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A POPULAR 96.3
GUIDE TO THE ELECTROTYPE:

CONTAINING
CONCISE & SIMPLE INSTRUCTIONS
IN
THE VARIOUS PROCESSES OF ELECTRO-METALLURGY,
WITH THE
ART OF MOULDING
IN PLASTER, WAX, FUSIBLE METAL,
ETC., ETC.

BY J. H. CROUCHER,
EDITOR OF THE "PHOTOGRAPHIC MANUALS."

PART II.
GILDING, PLATING, DEPOSITION OF ALLOYS AND OXIDES,
ETC., ETC.

LONDON:
T. & R. WILLATS, OPTICIANS, 98, CHEAPSIDE;
AND ALL BOOKSELLERS.

ENTERED AT STATIONERS' HALL.

1848.

A POPULAR

GUIDE TO THE ELECTROTYPE:

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THE VARIOUS PROCESSES OF ELECTRO-METALLURGY,

ART OF MOUNTING

IN PLASTER, WAX, RUBBER, METAL,

ALFRED BOOT, PRINTER, 3, DOCKHEAD, BERMONDSEY.

BY J. H. CROUCHER,

CHIEF, PLATING, DEPOSITION OF ALLOYS AND OXIDES,

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A POPULAR GUIDE

THE ELECTROTYPING

THE Editor of this work has to apologise for the long interval which has elapsed between the publication of the first and second parts. The delay has been unavoidable, and he believes that the information attempted to be conveyed will be found only the more recent and correct, from the circumstance that it has been much longer in preparation for the press than was originally intended.

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A POPULAR GUIDE TO THE ELECTROTYPE.

IN the former part of this Work we attempted to give a clear and simple outline of the principles upon which the process of Electrotyping is conducted, the apparatus made use of, and the precautions necessary to secure successful results. We there referred more particularly to the reduction of one metal, copper; as presenting a very useful and elegant example of the art, and as preparing the way for its practice where greater care and experience were necessary. The practical information thus acquired will enable the amateur to proceed with some degree of confidence to the more delicate processes which we are now about to describe.

The reduction of the most precious metals is effected upon exactly the same principles, and for the most part with the same apparatus, as the less valuable, only the greater worth of the material employed requires more particular care and caution to avoid loss and waste.

The great beauty but extreme costliness of articles manufactured in gold and silver, early led to the practice of covering some cheap metal with a thin coating of the more valuable. This process, termed in relation to gold, gilding; and to silver, plating; was, until recently, performed in various ways, of which we may mention the following as the principal. GILDING by Mercury, as formerly practised, was an operation most baneful to the health of those engaged in it; gold in a state of fine division being mixed with mercury and the amalgam rubbed over the article to be gilded, the mercury being subsequently

driven off by heat. The disastrous effects produced by the vapour on the health of the workmen, directed the attention of philanthropic philosophers to the discovering of some better method of accomplishing the object. One of these, formerly patented by Elkington, was called **WATER GILDING**; here the metal having been thoroughly cleansed, was introduced into a boiling solution of oxide of gold in potash; after remaining some time a thin coating of gold was obtained, an equivalent of silver being dissolved. The solution was prepared by adding caustic potash, or its carbonate, to the ordinary solution of gold, till the precipitate is dissolved.

Plating was managed on a different plan; a bar of silver, generally mixed with a small proportion of copper, was soldered on a bar of copper; the bar was then rolled out in a press till, as the two metals have a pretty equal expansion, the silver formed an exceedingly thin surface. This was called plated metal, and was afterwards hammered into the required shape. The edges were generally stamped out of a sheet of silver with a die, the hollow parts filled up with solder, and then united to the other parts by soldering. There was nothing objectionable in this process, indeed the silver is hardened by the rolling, and wears better in consequence; but it was expensive, and the articles could not be re-silvered when the silver was worn off.

The discovery of Electro Gilding and Plating has, to a very considerable extent superseded the old methods. Brugnatelli, so far back as 1805, succeeded in gilding two large silver medals by means of the pile of Volta, a fact recorded in the 21st volume of the Philosophical Magazine. Several years afterwards the experiments of M. Becquerel appears to have directed the attention of M. De la Rive to this subject; and though his plan was not successful in every point of view, it may be regarded as the origin of the present system. Improvements were made by Messrs. Boettger and Elsner, but it was not until the employment of the battery was suggested by Mr. Smee, that the art rose to its present importance. Adopting this suggestion, Messrs. Elkington and De Ruolz, in 1840, simultaneously introduced the patented method which, with some modifications, is now universally adopted. It depends upon the decomposition, by means of a constant battery, of the cyanide of gold dissolved in cyanide of potassium. It possesses the advantage of gilding objects of any size, in all metals, with expedition and economy, upon polished or plain surfaces, with the different thicknesses and various tints required by commerce.

In describing this process we shall refer 1st, To the solutions used ; 2nd, To the method of cleansing and preparing the articles for gilding, and 3rdly, To the apparatus required, and the method of using it.

GILDING SOLUTIONS.

A variety of preparations of gold have been suggested for use in the electrotyping process : the following are among the most important. The first is the solution recommended by the patentee ; 1, Dissolve 1lb. cyanide of potassium* in one gallon water, and to this add 2 ounces oxide of gold.† The mixture is at first of a yellow tint, but by standing becomes transparent.

No. 2, has been employed by Mr. Ruolz—Dissolve 10 parts cyanide potassium in 100 parts distilled water; filter, and then introduce 1 part cyanide of gold prepared with care, well washed, dried, away from the light, and then pounded in a mortar with a little water, in which it is left to become thoroughly hydrated. Put the liquor into a well stopped bottle, keeping it from the light, in a moderately warm temperature, and shaking it frequently. In two or three days it will be fit for use.

No. 3. Gold solution of Mr. Briant, of St. Petersburg.—A solution of 428 grains gold in nitro-muriatic acid is reduced to one-fourth by boiling and then evaporated, but not to dryness. The chloride of gold thus formed is dissolved in hot water, to which is added $\frac{1}{2}$ lb. powdered magnesia : this will precipitate the gold in union with the magnesia. The precipitate being separated by filtration, is carefully washed, and is placed in a flask, and upon it is poured gradually about 6 oz. of nitric acid. On its ceasing to effervesce, the precipitate is again filtered and washed until no trace of acid remains ; and this residuum is boiled in a hot solution of 7766 grs. prussiate potash ; when it boils, add 658 grains of caustic potash dissolved in cold water, and well mix it. The solution is allowed to cool and filtered for use.

No. 4. Mr. Boettger uses chloride of gold, 1 part in 100 parts of water—the chloride to be as neutral as possible. In this case, the

* In order to prevent confusion in the text, we refer the reader to the Appendix for the formulas for making the substances employed in their preparation.

† See Appendix.

object to be gilded does not remain more than one minute at a time in the solution, but the immersion is repeated five or six times, washing it carefully between each, with fine linen, in pure water.

No. 5. The following is recommended by Mr. Woolrich.—Dissolve 4 oz., troy, fine gold in a mixture of nitric acid, 11 fluid oz.; muriatic acid, 13 oz.; distilled water, 12 oz.; evaporate and crystalize the solution; then dissolve the crystals in 1 lb. distilled water, and precipitate with magnesia, washing the precipitate first with distilled water acidulated with nitric acid, and then with water alone. Add to this precipitate enough of the following solvent to dissolve it, and one fifth more; stir it, and in about 24 hours it will be fit for use. The solvent which answers for several other metallic solutions is made as follows. Boil together in an iron vessel, 28 lbs. best pearl-ash, and 30 lbs. water, and when cool filter, to this add 14 lbs. distilled water, and then pass sulphurous acid gas* through the liquor until it is saturated, when it is to be filtered for use.

No. 6. This solution, used by Dr. Frankenstein, whose ingenious method of gilding was particularly noticed in the first part of this Manual, is as follows:—1 part chloride gold, 10 parts ferro-cyanide potassium, 10 parts sea salt, and 50 parts water. The ferro-cyanide potassium may be replaced in part or entirely by the sub-carbonate potash, in that case the quantities will be as follows:—chloride gold, 1 part; ferro-cyanide potassium, 6 parts; sub-carbonate potash, 4 parts; salt, 6 parts; water, 10 parts. The mixture is boiled during some time in an earthen pot, and the clear yellow liquor is decanted for use.

SILVERING SOLUTIONS.

No. 1. The solution most commonly used in plating, consists of a double cyanide of silver and potassium, and is usually prepared by dissolving either the oxide or cyanide of silver in a solution of cyanide of potassium. The latter is preferable as less impure than the other.

OXIDE OF SILVER is procured by pouring on small pieces of silver

* This gas is obtained by putting two parts mercury and three sulphuric acid into a glass retort, and applying heat until effervescence ensues, when the gas will be disengaged, and should pass through mercury, into the receiver; or by adding the acid to well burnt charcoal in a flask, applying heat and receiving the gas through water.

in a glass vessel, equal parts of concentrated nitric acid and water; when the metal will soon become dissolved. Unless the silver employed be quite pure, it is most probable the solution will have a greenish colour, which arises from the presence of copper; by putting a few pieces of copper into the solution, the nitric acid will combine with the metal, and the silver will be precipitated in the form of a greyish powder. Dissolve this afresh in nitric acid and water; put the liquid into an evaporating dish and drive off a portion by the application of a spirit lamp; crystals of nitrate of silver will soon form. Prepare a good quantity of lime water by stirring lime in water and filtering the solution. Put the crystals of nitrate of silver into the lime water, which will immediately change to a brownish colour; and after some time a dark brown precipitate will be collected, which is *oxide of silver*. Pour off the liquor and reserve the precipitate for use; to be sure that all the silver is withdrawn from the solution, add fresh lime water; and if any further precipitate occurs treat it as before. The oxide thus obtained should be kept in a bottle with water.

One half ounce of oxide of silver added to 4 ounces of the cyanide of potassium, prepared as directed in the Appendix, and dissolved in 1 quart water, forms a good plating solution.

CYANIDE OF SILVER is easily procured by taking a neutral solution of nitrate of silver, and carefully adding a solution of cyanide of potassium; a white precipitate will fall, which is cyanide of silver. Of course the cyanide of potassium is added until all the silver is withdrawn from the nitrate solution. One half ounce of this salt is added to a solution of 4 ounces cyanide of potassium in 1 quart water as before. This solution is purer than the former.

2. Mr. Rockline recommends the following as a very superior solution. Dissolve the oxide of silver in citric acid, evaporate it to dryness, and put the salt thus formed into a porcelain tube, which is heated to 212° Farenheit. Then pass through the tube for some minutes a current of dry hydrogen. When the tube is cold, withdraw the salt which is to be dissolved in cold water. This solution must always be used cold.

3. The silvering liquor of Mr. Woolrich, consists of 12 oz. crystallized nitrate silver dissolved in 3 lbs. distilled water, gradually adding the solvent, the composition of which is stated under the head of "Gilding Solutions," and leaving it as long as a whitish precipitate falls; the precipitate is then washed and redissolved in a sufficient quantity of the

solvent, to which is added one-sixth part more, so that the solvent may be in excess. At the end of 24 hours it is ready for use.

4. Mr. E. Tuck employs the bi-carbonate ammonia, of which he dissolves 70 parts by weight, in distilled water, and to this liquor, adds 56 parts, by weight, of sulphate of silver, or 134 parts cyanide of silver, boiling the liquor until the silver is entirely dissolved. He uses the sulphate of silver for covering German silver, and the cyanide silver for copper: he varies the strength of his solutions; the maximum used by him, containing 107 grains bi-carbonate ammonia with half an ounce sulphate silver to a pint distilled water.

5. The preparation used by Dr. Frankenstein, is made as follows : 1 part chloride silver ; 5 parts cyanide of potassium dissolved in water ; 5 parts carbonate of potash ; 2 parts salt water ; 5 parts liquor ammonia ; and 5 parts water. This mixture is heated during 30 to 45 minutes. The water is replaced as it evaporates to facilitate the solution of the salts. When the liquor has cooled and become clear, it is decanted to separate the deposit, and preserved for use in a well-stopped phial. The amateur must be reminded, that solutions of silver which contain ammonia should be used with great care, as by evaporation, dried particles may attach themselves to the mouth or sides of the phial, and form the compound known as fulminating silver, which will explode violently with the slightest friction.

These are some of the most approved receipts for the solutions used in Electro-gilding and plating. The student is recommended, however, to use No. 1. at first, until he is somewhat accustomed to the process. Alkaline solutions are always to be preferred, and it should also be borne in mind that in almost every case, the solutions ought to be exempt from acid and when any is present it should be neutralized by adding carbonate of potash.

PREPARATION OF SURFACES TO RECEIVE DEPOSITS OF GOLD AND SILVER.

Almost all metals are liable to contract a coating of oxide from even a short exposure to the influence of the atmosphere, and it is to the removal of this coating that the operations now to be described are directed. These must be performed with the greatest care, for unless

the cleansing of the surfaces to be covered be perfect, the adhesion of the two metals will be interrupted, and the deposits will blister and rub off with a little friction. There are several methods of cleansing the surfaces of metals to be gilded or silvered. If very much oxidized, the piece should be heated over a spirit lamp or a clear fire until it becomes of a dull red colour, when it should be plunged in sulphuric acid, diluted with 8 or 10 times its volume of water, and left until it assumes a brilliant metallic colour. When the pieces are soldered together, or from some other circumstance cannot be exposed to so great a heat, they must be boiled for some seconds in diluted sulphuric acid. The strength and temperature of the acid solution should be proportioned to the effect to be produced, so that if the gilding or silvering is to be dead or flat, after heating it to a red heat as before directed, it should after cooling a little be boiled for a short time in sulphuric acid diluted with about seven times its volume of water; this will produce a roughness which favours the desired appearance. Objects thus treated require to be submitted to another process of cleaning, which is performed in one of two ways, called the dry and wet method.

THE DRY METHOD is considered the best: articles cleansed by this method do not so readily acquire a fresh coating of oxide, but it cannot be readily applied to such as have much chasing or elaborate work of any kind. The cleansing is performed by well brushing with a plate brush, using Calais-sand, emery, pumice, rotten-stone, Tripoli, &c. according to the surface required. The action of the powders may be assisted by dipping the brush in a very weak solution of muriatic or nitric acid. This method is sufficient for many purposes without the former, as for medals or other copies obtained by the electro-type process, whose surfaces are usually tolerably exempt from oxidation. When from the nature of the object the dry method is inapplicable, **THE WET METHOD** must be adopted. Cleaning by this method is performed by attaching the object to a wire and immersing it in one or other of the following liquids:—nitric acid diluted with half its volume of water, the articles remaining in only one or two seconds; or nitric acid 2 parts, sulphuric acid 1 part, soot and salt, of each 1 part.

A mixture called pickle is sometimes used, consisting of sulphuric acid 64 parts; nitric acid 32 parts; muriatic acid 1 part; and water 64 parts. An immersion of a second or two is sufficient, and for delicate objects the mixture may be still more diluted.

After the use of either of these baths the articles must be well

washed in pure water to remove all traces of acid, and they may then be boiled in a solution of soda or potash, or immersed in a bath of caustic potash, or caustic soda and ammonia. The washing should be again carefully attended to, and if to be placed immediately in the decomposition trough, they should be dried, either by pouring boiling distilled or rain water over them, or by placing them in hot box-wood saw-dust. When they are to be reserved for a future occasion, they should be immersed in the saw-dust, and remain there until they are to be used.

Iron and steel may be cleaned in diluted muriatic acid, or by the following method employed by Dr. Fau. A small plate of zinc is plunged in water acidulated with sulphuric acid; the object to be cleansed is then connected by a wire with the zinc plate, and then plunged into the dilute acid. After remaining a few minutes the object is withdrawn, again connected with the zinc, and both are plunged into a saturated solution of sulphate copper, to which has been added a 20th part of sulphuric acid; when a thin coating of copper has been obtained, it must be thoroughly washed and immediately submitted to the action of the battery, either for thickening the coating of copper, or to gild or plate it.

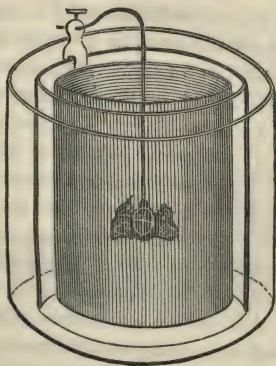
M. Bequerel, who has devoted considerable time and attention to the subject of electro-plating and gilding, has recommended amalgamation as a means of ensuring the adhesion of gold or silver. The articles are first to be thoroughly cleansed by the methods pointed out above; then dipped into a solution of proto-nitrate mercury, and afterwards well washed in plenty of water. They are to be well rubbed with leather in order to promote the spread of the mercury, and the operation must be repeated until the whole surface is covered. One advantage belonging to this method is, that either a burnished or a dead appearance may be produced at pleasure. If the surface is highly polished, the gold or silver will be equally brilliant, if the mercury is only just spread over without polishing the deposit also will be dead. The process is very valuable in gilding, as a very thick coating of gold may be obtained. The mercury can be afterwards driven off by heat.

GILDING AND PLATING APPARATUS.

Both the single cell and battery apparatus are used in reducing the precious metals, the latter will, however, be found the most advantageous.

THE SINGLE CELL APPARATUS differs but little from that employed in electrotyping with copper (described at page 32, of First

Part), but as the solutions are so much more valuable, every thing which will tend to economize their use is carefully attended to. The zinc surrounds the porous cell instead of being placed within it, while the object to be coated is immersed in the solution contained in the porous cell (see fig.): this apparatus may be obtained either round or flat as may be found most convenient. The flat cell will of course be found more advantageous for a large object.



The outer jar of this apparatus is charged with water, very slightly acidulated with sulphuric acid, and the porous cell is filled with the solution of gold or silver. The zinc being placed in the outer jar, the object to be silvered to which a wire has been previously attached, is connected with it by means of a binding screw, and is then immersed in the solution, when a precipitation will take place almost immediately. The colour of the gold or silver when first deposited, varies somewhat with that of the inferior metal of which the object is composed, and some directions will be found further on for regulating the colour and thickness of the deposits. If, however, the surface of the deposit presents a black streaky appearance, it is a sign that hydrogen is being evolved, an effect most particularly to be avoided, and arising most frequently from the strength of the acid solution in the outer cell, which should be immediately diluted; or it may arise from the employment of two large a surface of zinc in proportion to the size of the object; or from the gradual withdrawal of the silver or gold from the cyanide solution: in which case more of the oxide should be added to

the cyanide solution. The first of the solutions given at pages 7 and 8, may be used with advantage in the single cell. If carefully managed, and the metal has been properly cleansed, a good surface of dead silver, sufficient for the silvering of medals, &c., will soon be deposited, which can be burnished with leather and the plate-brush. A longer time will be required to produce an equal surface of gold : and if the objects are to bear the wear and tear of common use a much thicker coating must be obtained. M. Becquerel has proposed the following plan for gilding with a single cell, which he has found to answer extremely well. He recommends the use of a glass or porcelain bell, the upper part of which is made tubular, with a neck on the outside. The tube is filled with ordinary clay deprived of its lime and well worked into a paste, and is kept in place by a piece of linen cloth tied over the neck. The bell fits into a frame of wood which supports it when reversed, and being filled with the solution of gold, is placed in another vessel which contains a solution of common salt pretty well saturated : the solution should be of an equal height, to prevent the difference of pressure from forcing the liquid in one vase into the other. A ring of zinc, which must not be amalgamated, is placed in the outer vessel so as to surround the tube which contains the clay, and the article to be gilded in the inner one, connection being made by a wire passing between them. The gilding solution employed in this case is prepared as follows. Make a solution of 1 part chloride of gold, 10 parts prussiate of potash, and 100 parts of water ; filter this to separate the cyanide of iron, then add another 100 parts of a saturated solution of the prussiate. This preparation produces a dullish gold ; by adding an equal quantity of water a better colour is obtained, and the solution may be even weakened to a still greater extent : the weaker the solution the finer the deposit. If any iron remains in the solution the gold will have a dirty appearance, but to remedy this the object must be washed in water acidulated with sulphuric acid, and lightly rubbed with a linen cloth to remove the non-adherent deposit. In general a deposit will be obtained in about ten minutes, but at the ordinary temperature it would require many hours to obtain a very thick one. The rapidity of the process is much assisted by heat, in which case the whole apparatus must be put into a bath of warm water, 60° to 70° Farenheit ; the gilding however is not always so beautiful as at the ordinary temperature.

The ordinary porous cells may be used instead of the glass bell, but in this case instead of the solution of salt, a solution made precisely

like the gilding solution just described, but without any gold, and with the addition of a little common salt is made use of. By surrounding the porous cell with a half liquid paste of clay, contained in a sail-cloth bag, the saline solution may be used without danger, as no mixture of the liquid will take place, at least not sufficient to produce any ill effects. Uniformity of gilding is produced by the circular form of the zinc, and even when the glass bell is used, if the position of the object to be gilded be occasionally reversed, the current will act with pretty fair regularity. M. Becquerel found the apparatus answer very well for pieces of silver, or for silver ornaments, producing a beautiful colour, red, yellow, or greenish, according to the thickness of the gold; the gilding proceeds most rapidly on the highly polished parts, the dead gold requiring a longer time to produce the same effect. The coating of gold is sufficiently adherent to bear the burnisher, or even to stand polishing on the lathe. Cylinders of silver well covered with gold can be drawn into wire, producing a perfect thread of silver-gilt.

Vases and other objects in copper, brass and bronze, perfectly cleansed with nitric acid and soot, gild rapidly under favourable circumstances, ten minutes having been found sufficient to give a coating, which would support colouring and burnishing. Copper cylinders thus gilded will bear drawing into wire. This plan has been adopted for gilding thin plates of copper which are afterwards stamped out to form rings and other jewellery.

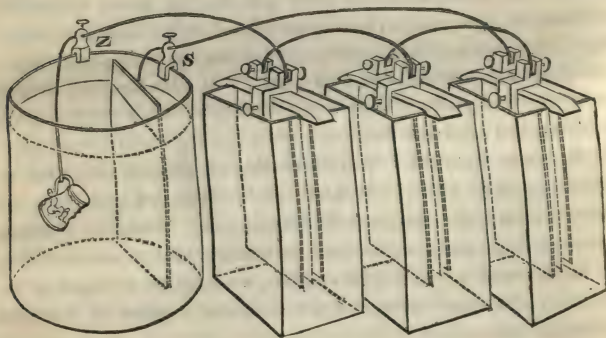
BATTERY PROCESS.—Notwithstanding the success which has attended the single cell in the hands of M. Becquerel and others, the battery process is the one generally adopted; and it certainly possesses advantages of no small value, more particularly that of accomplishing the dissolution of a pole of gold or silver, whereby the strength of the solution is maintained without the trouble and expense of first producing the oxide of gold.

We have in the former part described some of the more useful of the various kinds of battery which have been brought before the public. For the present purpose either Smee's or Daniel's is generally preferred. A decomposition cell of glazed earthenware, or better still of glass, of a size proportioned to the objects to be operated upon, so as to economise the use of solutions, two connecting wires, and an anode or plate of the metal to be deposited, will be all that is required in the way of apparatus for gilding or plating on a small scale. By referring to the description of Smee's Battery, page 16 of part 1, it will be found

to consist of a plate of platinized silver interposed between two plates of zinc, the whole being so arranged as to be contained in a small earthenware vessel. When the battery is to be put in action this vessel is charged with water, acidulated with sulphuric acid in the proportion of one part acid to 10 parts water.

Although the processes of gilding and silvering are very similar it will be perhaps desirable to notice each distinctly, referring first to that used in working with the more noble metal.

GILDING BY THE BATTERY PROCESS.—The size of the decomposition trough, and the number of cells of the Battery to be employed, must depend upon the work to be performed. One or two half-pint cells of Smee's or Daniel's battery will be sufficient for small medals, and three or four for larger objects. The battery is charged with water but slightly acidulated with sulphuric acid, the decomposition cell of a suitable size, is filled with the auro-cyanide solution. The connecting wires of the battery are arranged as in the figure, so as to pass across the decomposition cell. To the wire which is connected with the silver of



the battery may be suspended, by a finer wire of platinum, or gold, a plate or wire of gold, which should be procured of the most perfect purity, and which should bear some proportion in size and in figure to the object to be gilded. The object having been most carefully cleansed and prepared by some of the methods pointed out in page 10, may be attached in the same manner to the wire connected with the zinc of the battery, and when every thing is arranged and the piece of gold forming the anode is immersed in the cyanide solution, the object is to be introduced, carefully, so as to avoid air bub-

bles which might form on the surface; in the course of a few minutes a coating of gold will appear which must be examined to ascertain whether it is of the character required.

The character of the deposit will depend upon the relation which the power generated bears to the size of the object and the strength of the cyanide solution. The laws which regulate the deposition of metals from their solutions were stated in the first part of this work, at page 41, which should be carefully studied by the amateur. It will be there seen that the metal is thrown down in the form of a black powder when from the strength of the current of electricity, or the weakness of the solution, hydrogen is evolved from the negative plate of the decomposition cell. Now this is the danger most to be apprehended in the process of gilding; and if on inspection black streaks are found upon the surface of the object, immediate steps must be taken to prevent further mischief, either by reducing the strength or quantity of the acid solution with which the battery is charged, by removing the piece of gold or anode further from the object, or raising it out of the cyanide solution so that a smaller portion of its surface is acted upon. When the power employed is too small a contrary effect will be produced, the metal will be thrown down in angular crystals, wanting in cohesion, and of a bad colour.—The remedy is obviously the reverse of the former; to strengthen the acid solution, to bring the anode nearer to the object, or to increase its volume. The desired medium will be obtained readily after a little practice. The temperature of the cyanide solution will also have much effect upon the character of the deposit. Some advantages may certainly be derived from the application of heat; the operation is more rapidly performed, and the expansion of the metal to be covered, thus produced, is favourable to the adhesion of the gold, the two becoming more intimately connected by subsequent contraction on cooling; but very great care is necessary to preserve the reguline character of the deposit or all the expected increase of adhesion will be lost. The heat may be applied in various ways: the decomposition cell may be placed on a stove or in a sand bath, or a jet of steam may be introduced into the solution contained in it. The time required for the operation of gilding depends as a matter of course on the thickness required; for articles which are gilt for effect only, a very few minutes will suffice, but for those which are to be exposed to wear, some hours will be necessary, unless heat be employed. The quantity of gold deposited is ascer-

tained by weighing the object before immersion and when the operation is finished.

In the case of gilding the strength of the metallic solution is maintained as in the reduction of copper, by the gradual dissolution of the gold used as a positive pole. But this takes place in the latter case under circumstances which seem to demand some explanation. The solution consists of 1 part cyanide of gold dissolved, in 1 part cyanide of potassium, and the direct electrolytic action seems to be the decomposition of the cyanide of potassium; whereby cyanogen would appear at one pole and potassium at the other, but for a secondary action by which the gold is reduced in consequence of the metal potassium combining with the cyanogen of the cyanide of gold and setting the gold free. Now we have gold at the negative pole and cyanogen at the positive; but the cyanogen combines with the plate of gold, forming the positive pole, and the auro-cyanide thus formed being soluble in a solution of the cyanide of potassium though insoluble in water, the strength of the gold solution is thus maintained. It will, therefore, be seen how necessary it is always to have a considerable surplus of the cyanide of potassium in solution.

EVENNESS OF THE GILDING.—This must be carefully attended to by frequently turning the piece to be gilded, so that every part may be equally acted upon. To secure perfect uniformity it has been recommended to suspend the articles to a bottle jack, which method has the advantage of presenting every portion in turn towards the positive metal: connection is easily made through the jack.

GILDING VARIOUS METALS.—We have now given general directions for conducting the process of gilding to a satisfactory conclusion. Before passing to another portion of our subject, however, it may be well to refer to each of the metals to which the process is usually applied, in order to mention any peculiar circumstances which may attend its several distinct applications. Silver is gilded with great ease and regularity, and the colours obtained are of the greatest beauty. The cleansing is readily effected by the methods already pointed out, page 10, or with nitric acid and soot as recommended by M. Becquerel. A good way of preparing silver is to heat it to redness, and then to plunge it into water acidulated with sulphuric acid; the surface is then dead white and will receive a gilding accordingly. To obtain a brilliant surface, it is only necessary to polish it with pounce, charcoal, or rouge. Copper, brass, and bronze also gild easily and regularly, and may be

cleansed in the same way as silver: the thinnest possible coating may be given, or one so thick as to resist the action of cleaning. Tubes, capsules, and other chemical vessels of brass may be gilded so strongly as to resist the agency of boiling nitric acid.

Steel and iron gild well, but it is desirable to give a thin coating of copper in the first place, or a coating of mercury may be spread over the surface, first cleansing the article with sulphuric acid and potash, and then plunging it into a weak solution of proto-nitrate of mercury, containing about half nitrate of copper. After washing, it is spread by means of a wash leather, or if a polish is wanted, a scratch brush must be used. By these means dessert knives, surgical and chemical instruments, arms, the frames of spectacles, &c., &c., may be guarded from the effects of the air, acids, &c., easily and cheaply. Tin also requires a coating of copper, but although the appearance is very beautiful, it is difficult to put on a sufficient coating to wear well without greatly enhancing the price. The precipitation of gold from its solution by the galvanic battery is regular, and is proportioned to the time of immersion, so that the thickness of the deposit may be judged of from the length of time during which the object to be gilded is submitted to the action of the battery.

COLOUR AND NATURE OF THE GILDING.—The colour of the gold is influenced, as has been elsewhere observed, by the strength or weakness of the current employed, and by the description of metal operated upon. Thus a deposit upon silver will be of a light colour while that upon copper is redder and darker. Different shades of colour may be produced by adding to the solution of gold *a few drops* of the cyanide of silver or copper which will produce a corresponding difference in the tint. The brilliant or dead appearance of the gold depends upon the surface of the object operated upon; if that be highly polished the gilding will be likewise brilliant, if rough it will be dead, or what is called mat. When the whole surface is dead, the gilding is much improved by the process of colouring; indeed this is usually necessary on account of dirt and oxide which adheres to it; this is accomplished by one of the following processes. Take 40 parts nitrate of potash, 25 parts alum, and 35 parts salt, dissolve them in their water of crystallization, and having attached a brass wire to the article plunge it in several times. It is now placed in a furnace composed of an earthen cylinder and a grating also cylindrical, the space between the two being filled with ignited coke and charcoal. The temperature

is allowed to rise, the position of the article being frequently changed, until the saline matter with which it is covered becomes transparent, and is on the point of melting; at this moment the article is withdrawn and plunged into weak nitric acid and then in water, being afterwards dried in saw-dust in a stove. The above composition will act too powerfully on very thin coatings; in that case it may be replaced by the following, viz. 250 parts each nitrate potash and alum; and 125 parts each sulphate of zinc and sulphate of iron. A substance called gilding wax, composed of saltpetre, sal-ammoniac, sulphate of iron and verdigris mixed with melted wax, is often used; the article is covered with it and heated until it begins to smoke. The polish is produced by rubbing the part to be polished with a scratch brush, dipping it in soft soap and water, or in water acidulated with vinegar, until the desired brilliancy is produced. The burnisher is also used for this purpose, which is dipped in vinegar and water; when finished the article is washed in cold water, carefully wiped with a linen rag and dried slowly over a chaffing dish.

Before concluding this branch of the subject, we must refer to the ingenious mode of gilding by simple contact successfully practised by Dr. Frankenstein, some notice of which was taken in the former part. In performing the operations of gilding plating, &c. he adopts the following method: over a vessel of earthenware or glass is placed a bar of wood, to which is fitted a band of zinc whose two extremities are bent into the form of hooks so as to dip into the solution used and come into contact with the article to be operated upon. The extremities of the zinc must not be immersed too deeply in the solution, or the metal will be precipitated upon them in waste. Large objects must be brought into contact with the zinc ends in four or five points, and these should be changed occasionally. The points must be thoroughly cleansed in order that the electric action may be complete. The strength of the solution must be maintained by fresh supplies as the metal is deposited: the solution recommended for gilding will be found in page 8. The operation is accelerated by heat, but the metal adheres better when the temperature is more moderate. The articles submitted to this process must be very carefully cleansed; the bands of zinc moistened with a little acidulated water, and the oxide which becomes deposited carefully removed. In this manner may be gilt, silver, copper, brass, and even iron and steel, but these last metals should be previously plunged into a bath of water acidulated with a very small quantity of nitric acid and well cleansed. To produce a colour more

or less deep, the object may be kept for a greater or less time in contact with a copper wire as well as with the zinc, or a drop or two of a solution of copper or silver may be added to the solution of gold. By this method was gilded an immense cross, 47 feet square, placed on the top of the tower of the church of Gaming in Austria. The gilding presented a beautiful appearance and was sufficiently adhesive to bear the action of the burnisher. A few places remained uncovered which were afterwards gilt by the application of a liquid.

PLATING.

THE operation of plating being very similar to that of gilding, it will be unnecessary to repeat such of the directions given under that head as will apply to both processes.

PLATING BY THE SINGLE CELL is performed exactly in the same manner as the gilding, described in page 16. If the deposit is found to be streaked with black lines, the power must be reduced by weakening or lessening the acid solution, or the strength of the metallic solution must be increased by the addition of the oxide of silver.

BATTERY PROCESS.—This is also very similar to that used in gilding, the deposit of silver is rather slower than that of gold, although a somewhat less power will accomplish it. Two half pint Smee's will be sufficient for small objects. The anode should be of the purest silver, and the most preferable solution is that given as No. 1, under the head of Silvering Solutions, page 7. Care must be taken that a proper balance is kept up between the power and the work to be performed, as before directed. A deposit of silver may be thrown down, on gold and platinum for purposes of ornament. A coating of silver may be given to brass, copper, or bronze, with great ease, if proper care be taken to cleanse these metals thoroughly by one of the methods given at page 10; the coating may be so thin as to present a mere surface, or so thick as to resist the effects of long wear. Tin, iron, and steel and even lead may be silvered in the same manner. The silvering of steel presents, however, some peculiar difficulties which may be overcome by following the directions of M. Desbordeaux. His method consists in plunging the steel for a few seconds into a bath

composed of 1 part nitrate silver dissolved in 60 parts distilled water, and 1 part of nitrate mercury in a like quantity of water, mixed together, to which is added, 4 parts nitric acid. The steel will almost immediately be covered with a light black powder which may be wiped off with a piece of linen. The steel will be found to be perfectly cleansed and covered with a thin coating of silver, which will adhere with great tenacity, and upon which a thick coating of silver may be obtained in the battery, which will bear any degree of friction. Iron does not require this preparation, though the adherence of the subsequent coating is increased by it. The liquid may be used for some time without renewal: the effect of nitrate of silver on the skin should be borne in mind while performing the operation. When the silver is worn off any steel article once silvered by this or any other method, it can be replaced by carefully cleaning the damaged parts, rubbing them over with the preparation of silver and mercury, and then submitting them to the action of the battery. In order to secure the steel from oxidation, a tolerably thick coating of silver must be deposited. To ascertain whether the coating is sufficiently thick for this purpose, a portion of the silvered steel should be plunged for a short time in an acid solution of sulphate of copper; should the silver turn of a yellow colour from the action of the steel upon the copper, the silver is permeable and will not guarantee the steel from the action of acids; the deposit must be thickened. Care must be taken that the cyanide of potassium and silver used for coating steel has not been used before for coating brass or any alloy containing zinc, which quickly affects it: it is better in all cases to use old solutions for silvering such alloys. After the steel prepared in the above manner has been submitted to the action of the battery for a few moments and has become white, it is well to withdraw it, wash it in pure water, and submit it to a moderate heat until the hand can hardly bear it; this will increase the solidity of the silver: it may be then returned to the silver solution, and when the coating is thick enough it may be dried in a similar way. In silvering all metals, the current should be of moderate power, the connecting wires should be *long* and *thin*, (they may be wound round two pieces of glass for convenience) and the anode of a size suitable to the object to be plated, or at least it should only be immersed in the solution to an equivalent depth. German silver is soaked for three or four hours in a cold solution of carbonate of potash: after washing in cold water it is dipped into diluted nitric acid: again washed, dried and rubbed with a plate-leather, it is

dipped into a solution of common salt in which a little gum has been dissolved and immediately placed in the silver solution.

The dead or polished appearance depends, as we have said in reference to gilding, upon the character of the surface presented to the action of the battery : dead silver may be polished by the use of the burnisher.

The colour of articles newly electro-silvered is liable to be altered by exposure to the atmosphere, a disagreeable yellow tint appearing, owing to the presence of a sub-cyanide of silver reduced at the same time as the silver, and which decomposes under the influence of light. M. Mourey has suggested the following plan for remedying this defect. The articles are immersed in a hot solution of borax until they are covered ; they are then exposed in a muffle to a cherry-red heat which calcines the borax. On cooling they are immersed in water acidulated with sulphuric acid until perfectly clean, washed in plenty of water, and dried in hot saw-dust or in a stove. The beautiful white tint so much admired may thus be produced.

SILVERING DAGUERROTYPE PLATES.—Contrary to the expectations and assertions of many scientific men, the use of copper plates silvered by means of the galvanic battery, have been found to enhance the clearness and beauty of the image produced by the Daguerrotype process. The method of silvering differs in no respect from that already described, but extreme care must be taken that the silver solution and anode are perfectly pure, and that the power is so balanced to the work as to produce a firm even coating. The plates may be cleansed and polished on the lathe as in the ordinary process of the daguerreotype, or they may be heated to a red heat over a fire and polished on cooling. A glass vessel of a suitable size will serve for a decomposition trough, and two cells of a Smee's battery will give sufficient power : the connecting wires should be very thin and of considerable length, and the anode should be suspended over a support so that it can be raised or lowered at pleasure ; the solution should be that marked No. 1. Where more than one plate is to be silvered at once, a light wire cradle may be used which is to be connected with the zinc of the battery, and upon which the plates may be laid. At moderate temperatures, three to five minutes will be sufficient to produce a beautiful surface. If black specks or lines appear, the power must be lessened. The plates must be carefully washed and dried when taken from the solution. If carefully polished previously, the silver will present a brilliant surface ;

and will need little additional care to be ready for use. The plates thus prepared are far superior to those ordinarily used, the blacks, upon which the beauty of a daguerrotype so much depend, being greatly increased in intensity.

REDUCTION OF OTHER METALS,

BY THE BATTERY.

PLATINUM does not deposit so readily as gold or silver from the cyanide solution; but by using the double chloride of platinum and potassium, dissolved in caustic potash, the process may be accomplished with the greatest facility. It has however been found that the platinum so deposited is wanting in density and adhesion. M. Boettger states that he has overcome this difficulty by the use of a solution of the double chloride of ammonia and platinum in boiling water: when the heat has somewhat moderated, a few drops of liquid ammonia are added, and it is submitted to the action of a constant battery; in this way copper, brass, &c., may be effectually platinated. The proportions are as follows: 1 part of ammoniacal chloride of platinum with 8 parts sal-ammonia, in 40 parts water. The reduction of this metal is applicable to many useful purposes, such as the platinating of brass for chemical experiments, the preserving other metals from oxidation, &c.

The word platinizing is used by Mr. Smee to indicate the process by which platinum is thrown down in a black powder by means of a strong current, as in the preparation of the platinized silver plates used in his battery. Platinating refers to the ordinary process in which the metal is thrown down in the reguline or metallic state.

COBALT and **NICKEL** may be applied in the same way and for the same purposes as platinum. Mr Boettger recommends an ammoniacal sulphate of protoxide of Nickel.

COPPER.—We have already, in Part 1, described the methods adopted for the reduction of this metal; the double cyanide of copper and potassium may be used, but the deposition is slow, and is not accomplished without considerable power.

LEAD.—This metal may be deposited by the battery process from a solution of oxyde of lead in potash. Its utility is however very circumscribed, though it may be occasionally used with advantage in the manufacture of chemical vessels, in which the solidity of iron plate

may be combined with the resistance offered by the lead to the action, of saline and weak acid solutions. M. de Ruolz laid before the Academy iron pipes covered inside and out with lead; also, iron slates covered with lead. He recommends it particularly for machinery exposed to the action of sea water.*

TIN may also be reduced from a solution of its oxyde in potash. Its applications are more valuable than those of lead, and it may be deposited upon various utensils manufactured in copper, bronze, brass and iron. A galvanic process has long been in use for tinning the brass wire of which pins are made. The brass wire, and grain tin are put into water charged with cream of tartar; the two metals forming a regular pile, of which the pins are the negative pole, attracting the tin as it becomes dissolved to precipitate upon them.

ZINC.—Iron covered with a thick coating of zinc becomes capable of resisting the action of air and water, and is peculiarly valuable for a great variety of purposes. This has been accomplished by immersing the iron in a bath of melted zinc, but the iron so prepared loses much of its tenacity and forms with the zinc a brittle alloy, besides which the shape of the material operated upon is always more or less deformed. By the galvanic process, however, the zinc is deposited without these inconveniences; so that it may be applied to numerous useful purposes for which it was unfitted under the old process. Cannon balls, iron wire, &c. may thus receive a coating of zinc without their forms being in the least disturbed. Iron thus prepared is of the greatest utility in architecture; by its use, nails, bolts, bars, grates, balustrades, and a variety of other objects may be preserved uninjured by air or moisture. Messrs. Elkington, who have patented the process of zincing iron, recommend a solution of 1 lb. sulphate of zinc in a gallon of water, and the use of a feeble power.

M. De Ruolz, however, considers a coating of lead as preferable to one of zinc for several reasons; first, because of the extent of power required to reduce the latter which is 200 times greater than that employed in the reduction of lead.—Secondly, Because the protective power of the zinc is very circumscribed. If a portion, however small, of the iron is left bare, that portion oxydizes as rapidly as if no zinc had been applied to the rest of the surface.—Thirdly, Because zinc itself is a metal readily attacked, and, therefore, much inferior to tin

* See also, Zinc, below.

and especially to lead, of which also a thicker coating may be deposited. The price of lead is much lower than that of zinc, and it can be applied without much enhancing the cost of the metal coated. He employs a solution of litharge in potash; this last not being decomposed the bath thus made will serve indefinitely, and can be maintained at the same state of saturation by adding litharge, or employing a sheet of lead as a positive pole. The power required, as before stated, is small.

BY THE SINGLE CELL.

M. Becquerel, to whom the science of electro-metallizing is largely indebted, has published a very interesting paper upon the precipitation of Metals upon other Metals, in which he shows the effects produced by the employment of neutral solutions at a temperature of 140 to 212 degrees Fahrenheit. With the exception of thickness, a quality only obtainable by the use of the battery, a satisfactory deposit may be obtained by immersion only, aided occasionally by the contact of zinc. The coating is of course extremely thin, as the reducing action of the precipitating metals ceases when its surface is entirely covered with the metal precipitated; but it is very adherent, not only bearing the polish with the leather and rouge, but in many cases supporting the process of burnishing.

PLATINUM.—Take a solution of chloride of platinum as neutral as possible; and decompose it by a concentrated solution of potash. Wash the precipitate at first with a mixture of alcohol and water, then with alcohol to take up the excess of alkali without dissolving the double chloride. This, dissolved in distilled water, will give a solution entirely neutral, and when diluted with two or three times its volume of water, is ready for use. The temperature is now raised to from about 190° to 212° and the objects having been perfectly cleansed and polished are plunged into it: they become at first dull, clear gradually, become brilliant, and then the platinating is accomplished. A minute at most suffices for the operation: the objects must be immediately withdrawn and dried in sawdust; a longer immersion would injure the effect, as would a higher or lower temperature; care must be taken not to touch the object during the immersion with a piece of zinc, as in that case the deposit would instantly become black. It is indispensable to dry the object in sawdust after cleansing by acids, which, notwithstanding the washings, leave a slight trace of oxyde which the friction of the sawdust removes. When copper platinated is taken from the solution

and exposed to the air without drying, a rapid alteration takes place, and the piece becomes covered with the most brilliant blue and violet hues. The platinum deposited has a brilliant white silvery appearance. The alloy termed Maillechort takes the coating perfectly well. Iron requires a previous preparation. This method may be adopted in bronzing copper medals, and to modify the colours obtainable by the use of the peroxyde of lead of different thicknesses.* By this means remarkable effects of colours may be given which can be obtained in no other way.

PALLADIUM.—The preceding observations on platinum apply equally to this metal, that is to say, a double neutral chloride of palladium and potassium must be formed, containing one atomic proportion of each chloride, and the operation must be conducted in precisely the same manner. Objects covered with palladium have the appearance of platinum, perhaps a little whiter and with a brightness nearly equal to that of silver.

IRIDIUM AND RHODIUM.—The same mode of operation is adopted.

SILVER.—With a saturated solution of chloride of silver and salt at a temperature of about 158° Farenheit; a deposit of dead silver is obtained by simple immersion, which becomes brilliant under the action of the burnisher. At a boiling heat the silver becomes black, so that is necessary to operate within certain limits, the precise point being determined by the nature of the metal to be operated upon.

COPPER offers no difficulty in the employment of the double chloride; but to obtain the deposit upon metals but little susceptible of oxydation, it is necessary to touch the objects to be coppered with a piece of zinc immersed in the same solution.

ANTIMONY.—Copper becomes coated with antimony with great facility in operating with a solution of the double chlorides at a temperature of from 155 to 165° , aided by the contact of zinc. The metal deposited has a grey violet tint.

BISMUTH is precipitated in the same manner as antimony, it has a yellowish white appearance and is mat, only taking a polish by the use of the plate brush.

TIN.—Copper and iron take a coating of tin readily in the double chloride of sodium and tin at 155° , either polished or mat, according to the surface; but the contact of zinc is indispensable.

* See page 32.

LEAD.—Iron may be covered with lead immediately, by plunging a plate freshly cleaned into a solution of acetate of lead ; but if lead is to be precipitated on copper with the solution of the double chloride the contact of zinc must be employed, because copper has not the property of decomposing the salts of lead. Although this metal deposits upon copper, which has no action upon the double chloride solution, it is not possible to cover with it those metals which are electro-negative, by the aid of the contact of zinc. The lead deposited is of a whitish colour different from its ordinary aspect.

NICKEL AND COBALT.—The simple immersion of a plate of copper in the heated chloride solution will cause a deposition of the metals in the metallic state, but this coating is not adherent; by touching it with filed zinc the metal deposited becomes brilliant and very adherent, the coating will bear polishing either with rouge or with the burnisher. The colour is about the same as that of silver ; it is difficult to distinguish the colour of the two metals. If contact is employed the zinc should touch the reverse of the surface that it is wished to cover, and it is well to interpose a piece of copper wire between the object and the zinc. In covering brass the effects of the deposition vary with the nature of the alloy, those which have a large proportion of zinc resisting the deposit, copper may be always employed with advantage ; when the copper does not cover equally it is on account of some imperfection in the cleansing ; these places must be touched with a point of zinc, by which means an even deposit will be obtained. For cobalt and nickel, a temperature bordering on ebullition is necessary.

IRON may be deposited in the same way as nickel by means of the contact of zinc.

In those cases where the deposition of the metals is produced by the simple contact of zinc, this deposit may be augmented in thickness by the use of one or two elements of the galvanic battery, the metal to be coated being connected with the negative pole, and the circuit being completed with a piece of platinum wire.

REDUCTION OF ALLOYS OR MIXED METALS.

THE commission appointed to report to the French Academy upon the new processes of gilding, by Messrs. Elkington and De Ruolz having strongly recommended the latter gentleman to pursue his

enquiries with a view to ascertain the practicability of reducing mixed metals, he shortly afterwards presented to the Academy some specimens of iron bronzed by the battery process. In a short memoir on the subject, he lays down the two following principles respecting the simultaneous deposit of two metals; 1st, that the two metallic solutions which are to be mixed together must not be capable of decomposing each other, forming an insoluble compound; and 2ndly, that in the proportions adopted, regard must be had not merely to the relative quantities of the two metals which form the desired alloy, but also to the law of precipitation of each metal taken individually, or to the galvanic power necessary to precipitate in a given time a given quantity of each. Thus, in the case in question, in order to obtain an alloy composed of 90 parts copper and 10 parts tin, such as gun-metal, it is necessary to employ a solution containing the two metals in very different proportions, composed as follows: in 5,000 parts water dissolve cyanide potassium until the areometer marks 4 degrees, the temperature being at 77° Fahrenheit; dissolve in this liquor at a temperature of from 120 to 140°, 30 parts dry cyanide of copper, then dissolve at the same temperature 10 parts peroxyde tin; a part of the tin reduced to the metallic state will appear under the form of a black powder, the rest will dissolve. This bronze may be applied to a number of purposes which it is not necessary to enumerate.

Professor Jacobi finding that the method described was not altogether satisfactory in practical operations, principally because the solution frequently required to be entirely renewed, has published the following method of preparing, instead of an alloy of copper and tin, an alloy of copper and zinc, or of brass by the voltaic current. He takes a concentrated solution of cyanide of potassium, an anode of copper, and a cathode of some other metal, and passes through it a current derived from two or three pairs of a Smee's or Daniel's battery. As the liquor decomposes, the copper passes slowly into the state of cyanide which is dissolved in the cyanide of potassium. When it is sufficiently rich in copper, this metal will begin to deposit upon the cathode in a metallic form. Immediately any trace of this reduction appears, he withdraws the plate of copper and substitutes one of zinc. The copper will still be reduced upon the cathode, but will lose its red colour and pass to a yellow. When the desired colour is obtained, he replaces the anode of zinc by a plate of brass, and the cathode which served to test the progress of the experiment being also removed, he replaces it

by the object which he proposes to cover with brass. The liquid thus obtained may be used indefinitely, taking care to add cyanide of potassium from time to time. The more concentrated the cyanide of potassium the more rapidly the operation proceeds. If the surface of the object to be covered is polished, the alloy deposited will be so also, until a tolerably thick coating is obtained, when it will appear mat. The colour of the alloy may be modified at pleasure, and a deposit similar in colour to pinchback may be obtained by using with the anode of brass an anode of copper of greater or less superficial dimensions.

The process above described may be used with advantage for communicating a bronze to copies of medals, &c. procured by the galvanic battery. A similar process may be made available for obtaining solutions of gold and silver, using an anode of pure gold or silver with the solution of cyanide of potassium: alloys of gold and copper, or gold and silver, are procured in the same manner. It must be remarked, that in alloys of gold and silver, as in those of copper and zinc, the silver and the zinc being positive metals and more easily reducible than the gold or the copper, require the presence of a very large proportion of these latter metals in the solution.

An alloy of lead and iron much harder than lead and melting at a higher heat is formed by adding protosulphate of iron to a solution of lead in nitric acid in small quantities, so that the resulting solution is not very concentrated. This alloy was prepared by M. Majocchi.

DEPOSITION OF METALLIC OXYDES.

The advantages which would arise from the deposition of the inalterable oxydes of metals upon other metals as a protective coating, have engaged the particular attention of M. Becquerel, and he has discovered a method of depositing the peroxydes of lead and iron so as to secure perfect adherence: the plan is worthy the attention of the electro metallurgist. A solution of lead is prepared by dissolving 200 grammes, about 10 ozs. of caustic potash in about two quarts of distilled water, to which is added 150 grammes, $7\frac{1}{2}$ oz., lithage (protoxide of lead): the solution is now boiled for half an hour, then left to settle, and diluted with its volume of water. A porous cell filled with the solution, is placed in a vessel containing water, acidulated with about one twentieth of its weight of nitric acid. In the latter is placed a plate

of platinum, connected with the negative pole of a single Smee's or Daniel's battery ; the piece to be coated is connected with the positive pole of the battery, and placed in the metallic solution. An immediate disengagement of hydrogen takes place upon the platinum, and the oxygen in passing to the positive pole instead of oxydising the plate in the metallic solution, changes the protoxyde of lead contained in the latter, into a peroxyde, which being, on account of its negative state, attracted by the same pole deposits itself upon the metallic plate. In a few minutes it has become covered with the peroxyde of lead. If iron or copper is thus operated upon, the colour is black with a light brown tinge, and the piece when dried in sawdust will bear polishing with plate powder. On a silver plate the adherence is greater, and the colour a jet black, which will support the action of the burnisher. A bust in brass, coated with the oxyde of lead and burnished, has the appearance of a good bronze. While the hydrogen is evolved from the platinum pole, the operation is going on well, if this ceases, it must be remedied by cleansing the surface of the platinum by dipping it in nitric acid, and, if this does not succeed, by examining the state of the battery, or seeing whether any of the oxyde has passed through the porous tube into the acidulated water. The metallic solution must be renewed at least every twelve hours, or the adherence of the oxyde will be much diminished. If the action continue for some time, the precipitate will be of a yellow colour, which becomes deeper as the operation proceeds. The solution of iron is made by dissolving protoxyde of iron in hot water, and placing it under the receiver of an air pump to abduct all the air. Ammonia, also deprived of air by the same means, is added in a quantity rather more than is necessary to dissolve the protoxyde of iron. This solution is now used in the same manner as the solution of lead previously described, only that the porous cell must be carefully closed so as to keep out the air which has a great tendency to convert the protoxyde into the peroxyde of iron. As in the former case, hydrogen is evolved at the platinum plate, and the peroxyde of iron is deposited upon the object to be coated. Those metals whose oxydes are soluble in ammonia, ought to be excluded from this process which is more particularly applicable to iron and steel. A few minutes suffices to give a deposit of a brownish red colour something like precipitated copper, which takes a polish with leather and rouge, and when the surface has been well prepared beforehand, it will bear burnishing with a steel burnisher. If the immersion be continued for some time the

tint becomes deeper from time to time, until at length it becomes of a deep violet: The deep coloured deposits are however alterable, gradually changing to hydrate of peroxyde and losing their coherence.

The operations above described may be carried on at a moderate temperature, but if the operation be carried on at about 75° Farenheit the deposits have more solidity. The objects to be coated should be cleansed by what is called the dry method, but as greasy matters will sometimes adhere to the surface of iron, it is better to pass them through strong sulphuric acid, and wash them in a solution of potash, before placing them in the bath; or they may be left for some time in a concentrated solution of potash. To prevent the ammoniacal solution from undergoing any change by keeping, it may be prepared as follows: Put ammonia as strong as possible into a well stoppered bottle, and pour into it the protosulphate of iron deprived of air, until a precipitate begins to form; stop it, and leave it to settle. This preparation will be quite clear and will keep for some time.

COLORATION OF METALS.

Dr. Priestley, while experimenting on the electric battery, found that when a metallic plate is submitted to numerous discharges from a battery through the medium of a metal point, the colour of the plate becomes changed to a considerable distance round the central spot, and the entire space becomes covered with a certain number of concentric rings, of which each presents one of the beautiful colours of the spectrum. The smaller the point, the greater the number of colors, and the nearer it is brought to the plate the more rapidly was the effect produced, and the closer were the rings together, so that when the point and plate were in contact, the colors were produced at once, but with a very confused appearance. These coloured rings have but a slight adherence, and when steel is operated on and the discharges are powerful, crossings of the surface take place, which materially affect the appearance. These crossings do not take place upon silver, tin, or polished bronze. The rings may be produced upon gold, silver, copper, bronze, iron, lead, and tin. Nobili was the first who made known the production of colored rings upon plates of metal by means of deposits produced by voltaic electricity; phenomena analogous to those obtained by Priestley by successive discharges from an electric battery. He concentrated the

current coming from one of the poles of a galvanic battery, through a platinum wire, whose point was just plunged into the liquid to be decomposed, while the other pole was in connection with a plate of metal introduced into the same liquid. This plate was placed perpendicularly to the direction of the wire and at a very short distance from the point. The effects produced depend upon the nature of the metallic plate; upon its positive or negative state, and upon the nature of the solution employed: they are obtained in a few seconds with a battery of ordinary power. Nobili made a great many beautiful experiments, a description of which are to be found in the *Scientific Memoirs*, vol. 1, art. 5. These experiments have been repeated and modified by M. Gassiot.* The art of depositing metallo-chromes may be, and is, particularly applied to the decoration of the steel articles for which our manufacturers are so celebrated. The deposition is effected in the following manner. A saturated solution of sub-acetate, or sugar, of lead is made, which if at all turbid, must be filtered. A highly polished piece of steel is then placed in the solution, poured into a convenient vessel, and the wire connected with the negative pole of a galvanic battery of six or eight pairs laid beneath it, so as to come in close contact. By holding the point of the other wire in the liquid at a short distance above the centre of the steel a beautiful coloring will be produced, which will gradually enlarge, other rings forming within the first. These rings will present a series of colors analagous to those observed in the prismatic spectrum. A few seconds will suffice for the whole operation. By using a disc of copper the size of the object either flat, convex, or concave, though the concavity should be very slight, the object is more expeditiously and regularly covered. As it is difficult to hold the wire perfectly steady at the required distance from the centre of the object, a circle of card may be interposed, on which the copper plate may rest; the card acts as a non-conductor and prevents any deposition upon such parts as are covered by it. Bearing this in mind, a variety of figures may be produced, and almost infinitely varied, by cutting out stars, cyphers, shields, or indeed any figure upon the card; the parts of the object left exposed by the card, will receive a color depending upon its situation and upon the length of the experiment. The battery should be charged with water, only slightly acidulated with sulphuric acid: the colors so produced require some protection as the adhesion is by no means perfect.

* Proceedings Electrical Society, December 17, 1830.

M. Becquerel in a second memoir on the Deposition of Oxides and the Coloration of Metals, recurs to the deposition of the peroxyde of lead, and shows the manner in which it may be applied to the colouring other metals. He commences with the composition of the liquor used. This is essentially the same as that referred to in the former memoir. The alkaline solution ought to be completely saturated with peroxyde of lead, otherwise the deposits of oxyde, will dissolve in the alkali as soon as the circulation of the current ceases, or becomes less powerful. It is therefore necessary when the liquid has been used, to boil it from time to time in a flask with an excess of lithage, as much as possible out of contact with the air, to prevent the potash from absorbing carbonic acid. When it has served for a considerable time, and consequently, contains carbonate of potash, it must be boiled with quicklime, allowed to deposit the carbonate of lime formed, and filtered if necessary, or the clear part poured off from the residuum. After using, it should be put into a bottle and carefully stopped. The temperature of the liquor should be that of the surrounding air, not more than 50 or 60 degrees Farenheit. The success of the operation depends upon the proper composition of the liquor, its density, and its temperature, and also upon the intensity of the current and the perfect cleansing of the objects to be coloured. The coatings of peroxyde of lead are transparent, and therefore, whatever be the surface of the object, such will be its appearance when coated; thus, if the surface of the object be dull, the colours of the peroxyde will be dull also, if that be bright this also will be brilliant. Consequently the surface must be prepared with great care according to the aspect which it is desired to give. If the object be a plate of gold, or copper gilded, or of platinum, commence by rubbing it with a soft brush and water, containing a small quantity of alkali, and then well wash it: when the adherence of foreign matter is too strong to be overcome in this manner, the plate must be rubbed with a brush covered with rouge, then with a brush and alkalinized water, and then washed in plenty of water. The plate thus prepared, will speedily cover with the richest colours. These preparations are especially necessary, when, after having taken off the old colour, it is intended to use the plate for a second operation. After the plate is prepared, care must be taken not to touch it with the fingers, or any thing which would leave a stain upon it, so much does success depend upon careful preparation. Copper, iron, and other oxydable metals, do not receive colours so brilliant as gold, platinum, or copper gilt. Objects

in copper should be cleansed by heating them to a red heat, and then immediately plunging them into diluted sulphuric acid, marking 12° of the areometer, and at a temperature of from 140° to 180° Farenheit. They are then put into a mixture composed of three parts nitric acid, one part sulphuric acid, with the addition of a small quantity of common salt. Soot should be avoided, as it is likely to leave traces of grease. After thoroughly washing them in water, but without drying in sawdust, they are plunged into the alkaline bath. The objects may remain some few moments in the water, out of the influence of the air, but they must not remain in too long, for fear of alteration. When the copper has been well cleansed, and polished, very satisfactory effects of coloration are obtained, but these are much improved by polishing, or burnishing, particularly by the latter, which gives a vigour of tone not obtained by the first polish; but this operation introduces on the surface foreign bodies, which must be removed by a piece of fine linen moistened with alcohol, holding in solution a small quantity of potash, washing it afterwards in plenty of water. When copper, or brass, especially the latter, have but small dimensions, the coloration follows the same course as upon surfaces of gold, but when the dimensions are considerable, the surface remains bright during a longer or shorter time, and seems to be in a passive state like that of iron which has been plunged into concentrated nitric acid, in this case there is no effect of coloration. This is owing generally to a reduction of the lead upon the negative electrode.

When a saturated solution of protoxyde of lead, at the degree of density indicated above, is submitted to the action of a battery containing several pairs of plates, taking for positive electrode a wire, or plate of platinum, and for negative electrode, a plate of gold or platinum, a coating of an hydrous peroxyde of lead is deposited upon the latter which gradually augments in thickness, producing successively all the effects of colour which are presented by coloured rings on thin films. Immediately that the colouring is terminated, the colored plate must be withdrawn from the solution, and washed to take off all the potash which would otherwise re-act upon the peroxyde, to change it into protoxyde, which it would dissolve. The colouring commences ordinarily upon the edge of the plate in the points farthest from the points of attachment, in the parts, consequently, where the chemical action of the current is the strongest. It is on this account difficult, without particular precautions, to obtain uniform colours. The coating of

peroxyde adheres closely enough to support the polish with rouge and wash leather, but not of the burnisher of bloodstone, steel, or horn, because that this latter operation can only be applied to malleable substances, the parts of which spread under the burnisher, a property which is not possessed by the peroxyde of lead, the action rather detaching it from, than fixing it on the object. The peroxyde, of lead not being a conductor of electricity, the thickness of the coating is very limited.

Before entering upon the different processes to be adopted to obtain the proper effects of colour, &c. it is desirable to indicate the order of coloration. If the surface upon which the peroxyde is deposited be coloured, the colour dependent upon the thickness of its films is modified by that which belongs to the surface, producing effects which, while they change the colours of the coloured rings do not alter the succession of the different orders, which are not now composed of simple colours. With gold, for example, it is impossible to obtain blue since its yellow colour, joined with the blue, gives a bluish green, very beautiful it is true, but not the blue of the colored rings. With the platinum we have the blue, the ultra-marine, up to the finest blue that can be conceived. The following are the orders in which the colours appear upon a plate of gold.

First order—of the colours of coloured rings as given by Newton. Black, very pale blue, white, orange, yellow, red.

First order of the colours of coatings of peroxyde of lead. A slight deposit of which the colour cannot be characterized because of its fugitiveness—orange, deep orange, pearl grey, golden yellow, light red, beautiful prismatic red. Second order of Newton's coloured rings—sombre purple, purple, lively grass green, lively yellow, rose cramoisi. Second order of colours of the coatings of peroxyde lead—red, approaching to violet, bluish green, fine green, yellow, red. Third order of Newton—blue purple, lively grass green, brilliant yellow, rose, crimson. Third order of coatings of peroxyde of lead—claret, dark green, approaching to red; the colours after this become deeper and deeper until they arrive at a jet black. In comparing the colours of the coloured rings of Newton, and those of coatings of peroxyde of lead belonging to a similar order, very manifest relations are seen to exist between them; since, with some few exceptions, there is a difference only in the tints, the order of colours is very similar. Upon the copper appears the same order of colours, but with a reddish

tint which gives them intensity. Upon perfectly polished silver, a greenish yellow appears first, owing partly to the oxidation of the silver, then a yellow, red, blue and green; after that other colours which become deeper and deeper. Upon platinum all the preceding colours take a blue tint, those which are blue or bluish green give the most beautiful blue, that of ultra-marine. Upon iron and upon steel, the different series of colours show themselves with intensity, but in general they have a sombre tone from the grey colour of the metal.

To have a uniform colour several conditions must be established. First, The deposits of peroxyde of lead must be successive and very thin; this may be accomplished by taking for negative electrodes platinum wires of some 500th part of an inch in diameter. Each wire is introduced into the interior of a glass tube, of which one of the extremities is melted by a lamp, and the wire cut off at that extremity, in order to have outside the tube a metallic point, more or less fixed, by which the current is conducted: in this manner a current produced by a very small quantity of electricity can be made to circulate in the liquid. At the other end of the tube the wire is fixed with mastic, and must be of a sufficient length to connect itself conveniently with the battery. The negative electrode being thus reduced to the smallest possible dimensions, being but a section, almost microscopic, of a metallic thread, the deposit is gradual. The deposit of lead which, however, is inconsiderable when the action is slow, must of course be removed. Instead of one tube several tubes may be united together, so that all their points are in the same plane, or several wires may be introduced into one tube, closing the end, which is placed in the solution, cutting the ends of the wire and spreading them so as to form a brush. Secondly. —The objects must communicate with the positive pole of the battery. When they have only an extent of two or three inches, it is only necessary to connect them by an iron or copper wire, or to hold the object with a pair of iron pincers in connection with the battery, taking care frequently to file the interior of the branches in order to remove the oxyde deposited upon them, which being a non-conductor would hinder the current from circulating. If the object is large, the number of connecting wires must be multiplied, or the object may be held by some metallic grip, the position of which must be altered occasionally, that every part may become coloured. The greater the number of points the more uniform will be the deposit. If the object be square and small, fix a wire at each corner; if large, the connecting wire may touch

other wires passing across the object in different directions. For a triangle the wire may touch at the three corners ; for a circle, in the centre ; but in any case, a symmetrical arrangement ought to be studied if the deposit is to be uniform. Thirdly—The tube electrode, before described, must not remain at rest if the tints are to be uniform, because the deposit will be more abundant at those points of the object which are nearest to the tube. This tube must, therefore, be moved constantly above the surface to be covered, holding it always at the same distance which ought to be greater as the objects are of less superficial extent. When the surface is large, the tube electrode should be passed more rapidly over the surface, or more than one should be used. The particular distance, &c., must be determined by experience. M. Becquerel has given many very valuable suggestions upon the mechanical manipulation in this process, for which the reader should consult the original paper. For casts, or other objects which are not plane, the distance must of course be preserved by altering the plane in which the electrode moves.

To colour the interior of a hemispherical surface the object must be filled with the solution, putting it in communication with the negative pole by placing it on a piece of sheet copper already connected. The point of the negative electrode being placed in the centre of the section, and maintained there, is of course at an equal distance from all the points, and the colouring is uniform. With a cylindrical vase place the tube electrode in the axis, and move it up and down ; in a sphere, the point must be placed in the centre, and maintained there. When the object is immersed in the solution, the vessel containing it ought to be much larger than the object, which is placed horizontally in it. After the tube electrode has been immersed a few seconds the colour should be examined. If the desired colour has been obtained it must be immediately washed in plenty of water, and cold water poured over it plentifully, in order to wash away the least trace of potash, which would very soon change the colour.

In order to vary the colour and their intensities, one fact must be borne in mind—that the deposits formed upon the terminal line are the strongest, as well as those which are the nearest to the point of the tube electrode. Remembering this, nothing is simpler than by taking a certain number of communicating wires to attain the end desired. Thus, if we have a circle representing the horizontal projection of a cone, and wish to colour the central part green, we commence by plac-

ing the tube electrode for some seconds above that part; the surface will be covered with a deposit, which will be deeper than those elsewhere in its neighbourhood. This done, the tube is removed further from the surface above its first position, that the action may be uniform over the whole; the green will appear in the central part, whilst the lateral parts will have a tint gradually more uniform as they approach the centre. If it is wished to produce the effect of shading, a spiral ending at the centre is described with the tube electrode. With a little practice a flower may be *painted*, by the use of one or more tubes, with all its shades, so that in fact the tubes may be, to a certain point, compared to pencils; the perfection of the effect depending on the scientific and artistical skill of the operator. If a failure occurs the deposit of peroxyde can be easily removed, by placing it for a few moments in nitric acid, to decompose the peroxyde and dissolve the protoxyde, brushing and then washing the surface. M. Becquerel recommends a battery composed of a cylinder of copper of about four inches in diameter and about six inches in height, and one of zinc about one inch in diameter. The zinc is put inside the copper and both being placed in a jar, the battery is charged with very dilute sulphuric acid. About six of these are requisite to conduct the process he has described, the connections being made in the usual manner: the connecting wires, and indeed every part must be kept very clean that the current may not be interrupted. If the yellow hydrous peroxyde appears, the current has too great intensity and must be diminished till the proper effect is obtained. The colours produced in this way are subject to more or less alteration from the air, according to the metal on which the deposit is made, and in order to this preservation they must be protected by glass, or varnish placed over them. A varnish of linseed oil with litharge is best for the purpose, because it affects the colours less than turpentine or spirit varnish. The linseed oil varnish is composed as follows—Put into a varnish pot, a full pint linseed oil, three to five drams litharge in fine powder, and one and a-half drams sulphate zinc, and heat to a moderate heat during many hours. When the solution of oxide of lead is made, filter it to separate the excess of litharge. If the oil is too thick, it may be thinned with turpentine, which has been boiled previously in a flask with the litharge, to take up the succinic acid which might be in it, and which would change the colours. The varnish being prepared is laid on with a brush and dried at a moderate temperature. When the varnish is very dry put on a second coat and dry it. At the final application

of the varnish the blue of the second order disappears, so that the bluish green becomes a yellowish green; the yellow and the red change very little. As to the colours of the third order, especially for the dark green, they rest intact. By means of this varnish the objects are completely preserved. When it is wished to preserve the colours of the second order, with the exception of the bluish green and of the grass green, it is necessary the instant the bluish green is passed and the yellowish green begins to appear to stop, wash, dry, and put on the varnish—thus the colour is preserved. As this varnish is not quite transparent, but of a brown tinge, the colours lose their *eclât* but gain in solidity.

The effects of coloring above described are produced upon gold or copper gilt, and they take place, whatever may be the extent of the surfaces, but it is not the same with brass, nor always with red copper; in these cases a phenomenon appears, whose cause is not very plain but whose effects can be avoided.

BRASS.—When the object is small, two or three inches, the coloring operates immediately that the circuit is closed, and the more rapidly that the surface is small; but when it is larger the object rests bright during a long time, and even preserves its *eclât*. This passive state is evidenced by an abundant deposit of lead upon the negative electrode. In order to prevent this, a very small part of the object must be plunged into the alkaline solution, which will colour immediately, and then the neighbouring parts must be immersed until the whole is in contact with the object. The modification acquired by the surface treated in this manner is indicated by a sort of cloudiness which covers the whole, and of which the color is so fugitive as to be indefinable; but what is very remarkable is, that the small portion first immersed loses its colour and gradually recovers that of the metal, it being impossible to recover it. In a few moments after this cloud has appeared over the surface, the different phases of coloration, described above, begin to appear, the colors rivalling for brilliancy those produced on the most highly polished gold. When it is wished to color a piece of metal having considerable dimensions, it must therefore be placed upon an inclined plane passing into the solution, along which it slides down slowly; by this means there is, at each instant, but a very small portion of the piece submitted to the voltaic action. Red copper also, though less frequently, takes this passive state. It may be observed, that no enlargement of the negative electrode will affect the colors of large objects,

in these metals, unless the plan pointed out be adopted. Silver is never passive when its surface is properly prepared, but the coloring produced noway resembles that of other metals. When the surface is very highly polished and the current is not sufficiently intense to alter sensibly the silver, the colours are lively.

Platinum and copper platinized colour with the richest tints that can be produced by art. It is highly probable that the oxide of platinum combined with the peroxide of lead has something to do with the brilliancy of the colour. Blue is the dominant colour here, and it very nearly approaches that seen in natural flowers; but many colours of the series of coloured rings are obtained.

Polished steel colours easily when the surface has been properly prepared, and takes all the tints which are developed when this metal is heated, as well as those which depend upon the deposit of peroxide.

We have given M. Becquerel's account of this process at some length, because it was impossible to afford any clear idea of it, without going, into detail. It differs materially from that by which the plain colorings are produced. In that case a neutral solution of acetate of lead is used; in this, the solution is alkaline, and must be so. In the one instance colored rings are always produced, in the other the tints obtained are uniform.

New method of Engraving upon Silver, or upon Copper Silvered or Gilt. By M. POITEVIN, Civil Engineer, &c. Communicated by M. BECQUEREL.

"M. Niepce de Saint-Victor, an officer in the Municipal Guard, has discovered an ingenious method of copying designs and engravings on paper, upon glass, or upon plates of metal. M. Poitevin has transferred these copies to engraved plates in relief or in intaglio, by the assistance of which we can obtain impressions. Two or three hours are sufficient for the execution of this work.

"We begin by exposing a print to the vapour of iodine, which settles upon the black parts only. We then apply, with a little pressure the iodised print, upon a plate of silver or of silvered copper polished, as for the daguerreotype operation. The black parts of the engraving having received the iodine, give it off to the silver, which is thus changed into iodide of silver over the corresponding parts, and those only. The plate being then connected with the negative pole of a

voltaic pile composed of a small number of elements, is plunged for a few minutes into a saturated solution of sulphate of copper connected with the positive pole, by means of a plate of platinum. The copper is deposited only upon those parts which have not been attacked by the iodine and which correspond to the whites of the print. We thus obtain a perfect representation of the engraving, in which the copper represents the whites, and the iodide of silver the blacks. It is necessary that the plate should be kept but a short time in the bath of sulphate of copper, for if the operation is prolonged, it becomes entirely covered with copper. The plate, after having received the deposit of copper, is washed with much care; then plunged into a solution of the hyposulphite of soda for the purpose of dissolving the iodide of silver which occupies the parts corresponding to the blacks, then well washed with distilled water and dried. The plate is then heated to a temperature sufficiently high to oxidise the copper, which takes successively different tints, and the process must be arrested when it acquires a sombre brown colour. After allowing the plate to cool, the silver is slightly amalgamated, a little warmth being employed to facilitate at last the process. The mercury will not combine with the oxide of copper; thus we have a design in which the amalgamated parts represent the blacks, and the parts covered with the oxide of copper the whites of the engraving. The amalgamation terminated, we cover the plate with two or three leaves of beaten gold, and then volatilise the mercury by heat. The gold adheres only to the places of the blacks on the design. The gold which does not adhere is removed by a scratch-brush. Lastly, we dissolve the oxide of copper with a solution of nitrate of silver, and we then attack the silver, as well as the copper underneath it, with weak nitric acid. The lines of the print which are protected by the gold are not attacked by the acid, and we can thus obtain lines as deep as we may desire corresponding to the whites of the engraving.

“This last operation completed, the plate which may be compared to an etching is in a fit state for *proving* in the manner of wood engravings. For obtaining with the same design, cut, or engraved copper plates, we must operate upon the plate or copper covered with the coating of gold. In the bath of sulphate of copper, the parts which correspond to the whites are more thickly covered with copper than before. We remove with the hyposulphite the iodine or compound of iodine which is formed; we oxidise the coat of copper deposited,

and then amalgamate the gold, which can be removed with nitric acid, which dissolves at the same time the oxide of copper. In this process the whites are evidently preserved, and the cuttings represent the blacks, as in the ordinary engraved copper plates.

"The scientific question is resolved, and it remains an artistic one which demands the attention of those persons who are acquainted with the exigences of the engraver's art.

"The invention of M. Poitevin has been submitted to a commission composed of MM. Becquerel, Chevreul, Pelouze; and to this commission the Academy of the Fine Arts are invited to add some of their members."

We learn that another very beautiful and new application of the Electrotype process has recently been made in Germany, and ornamental works of the utmost beauty have been produced. We can well understand the practicability of the process, and hope to see it employed in this country, where, in the hands of our artists, we are certain it might be carried to the highest degree of perfection. The process is as follows:—An etching-ground is laid over a plate of copper, or any vessel formed of that material, and the artist draws his design as we would for the ordinary operation of etching, and indeed an etching is made in the usual way, the acid being allowed to bite deeply into the copper. Immediately this etching has been made, the plate or vessel—the etching ground still remaining upon it—is connected with the voltaic battery, and placed in a solution of the oxide of silver or of gold, in the cyanide of potassium. The circuit being completed, gold or silver, according to the solution employed, is precipitated on the copper; and from its surface having been roughened and rendered absolutely clean, it adheres firmly to it. The metallic precipitation is allowed to go on, until the more valuable and ornamental metal is raised considerably above the copper. The wax is then removed and the copper bronzed. In this way is procured a raised picture in gold or silver, which will admit of the utmost elaboration and extreme minuteness of detail.—See "*Art-Union*," April 1, 1848.

APPENDIX.

PREPARATION OF THE CYANIDE OF POTASSIUM.

This salt is obtained from the yellow prussiate of potash in the following manner. Half a pound of yellow prussiate having been dried and pounded in a mortar, is mixed intimately with three ounces of carbonate of potash also dried and pulverised. A crucible having been placed on the fire and brought to a red heat, the mixture is put into it; by maintaining the heat it will melt and become incandescent. Plunge into it, from time to time, a glass rod previously heated; the matter which will adhere to it, at first brown, then yellow, will at length become colourless and transparent. The operation is now finished, and the crucible may be withdrawn, and the contents, after settling for a few moments, may be poured off.

OXIDE OF GOLD.

Dissolve pure gold in nitro-muriatic acid consisting of one part of the former, and two parts of the latter. After evaporating to dryness, dissolve the residue in twelve times its weight of water; add to it a solution of carbonate of potash, in twice its weight of water, apply a moderate heat, about 170° , and a reddish yellow precipitate will appear. To render this anhydrous, boil it in water, which will change it to a brownish black colour, and form the oxide required.

GUTTA PERCHA MOULDS.

This material, valuable for so many purposes, is useful to the electro-metallurgist. Beautiful moulds may be made from medallions, seals, &c., by applying it in the following manner. For a medallion, a ring

of metal or wood is put round the edge as directed for metal moulds, (part I. page 21) taking care that the ring is sufficiently thick to resist a strong pressure, and at least half an inch higher than the surface of the medallion. A piece of gutta percha, of a size sufficient for the mould, and about the thickness usually sold for good stout boot soles, is then boiled in water, and when about as soft as putty, it is removed and forced into the ring containing the medallion, and a piece of wood, or, what is better, a piece of metal heated to 212° , placed on the top of the gutta percha. A steady pressure may be added by means of a screw press, or heavy weight, and continued until the gutta percha is perfectly cold and hard. If the plaster cast is soaked in boiled linseed oil and dried in the air, brushing it over every two or three days with fresh oil, until the plaster is quite saturated and bears a good polish, numbers of moulds may be made from the original, otherwise the operation will destroy them. Sharper impressions are obtained from medals because a greater degree of pressure can be used. The surface of the moulds, made as above, will take the plumbago necessary to render them conducting, readily, if brushed well over them. By the use of electro-typed copper dyes, some beautiful articles have been manufactured in this material, such as, Miniature Frames for Daguerreotypes, copies of Bas-reliefs, Cameos, Medallions, and a vast variety of useful and ornamental articles, which are prepared by bronzing so as closely to resemble metal. For small seals the Gutta Percha need only be boiled and then pressed into the mould by hand.

If the surface of the Gutta Percha is rough and wrinkled, it will be necessary to boil it in water, so as to render it as soft as possible, and then, to place it between two stout pieces of glass, or polished metal and submit it to a powerful pressure until cold, when an even and polished surface is obtained. Great care should be taken, not to remove the pressure from the die or mould until the Gutta Percha is cold and hard, as it is liable to destroy the outline of the mould. A small press, such as that used by chemists for expressing their tinctures, will be found to answer well. Gutta Percha may be used for precipitating troughs with good effect.

BRONZE FOR COPPER.

Suspend the article in a well stopped glass vessel containing a small quantity of hydrosulphuret of ammonia; a few seconds' exposure to the

vapour will be sufficient, the color being regulated by the time. After removing it from the vapour, the object is brushed with a soft brush, or chamois leather and rouge.

VOLTAIC GOVERNOR.

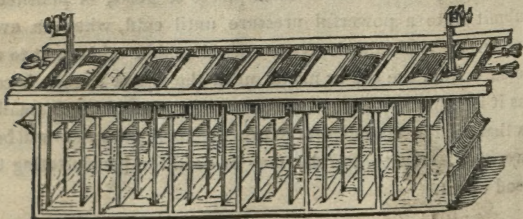
Mr. Bain has invented and patented a little instrument for regulating the amount of power employed in electrotype operations. To this machine, which he calls a "Voltaic Governor," are suspended the plates of the battery, immersed to such a depth as will produce the amount of electricity required, which passing through the instrument, by its action on an electro magnet, keeps the plates at the desired elevation. When however the action diminishes, the keeper of the magnet is released, and the plates sink until the current generated, is sufficiently powerful to cause the magnet again to attract the keeper.

MAGNETO ELECTRICAL MACHINE.

Attempts have been made to make use of this machine in plating and gilding, as the battery is costly and troublesome to work. The power necessary has been obtained by rotating an iron bar, armed with two coils of copper wire in front of the poles of a powerful steel magnet. It is much to be regretted however that this beautiful application of electro-magnetic power, will only perform its work on a small scale, and is therefore not of practical utility.

SMEE'S BATTERY,

ARRANGED FOR INTENSITY EFFECTS.



A very convenient and elegant form of Battery being easily put in action, and as quickly cleaned and put aside. Any number of Cells can be used in combination, from 1 to 10, or will form two or three separate Batteries.